

REMARKS

This paper responds to the final Office action dated March 14, 2007, in which claims 1, 3-16, 30-42, and 51-56 were rejected under one or both of 35 U.S.C. §112 and 35 U.S.C. §103(a).

Claims 1, 3-16, 30-42, and 51-56 are pending and at issue. Claims 30-42 are now under consideration, as the election requirement has been withdrawn, for which the applicants express their appreciation.

I. Summary of Claim Amendments

Independent claims 1 and 51 have been amended to more clearly recite what the applicants regard as the invention, and not for the purpose of overcoming an art-based rejection. Claim 1, as amended, specifies that polarization of the ultrashort laser beam is adjusted during the directing step to maintain the polarization relative to the waveguide propagation axis. Claim 51 now recites controlling the ultrashort laser beam during the directing step to maintain a polarization of the ultrashort laser beam relative to the waveguide propagation axis. No new matter has been added by these amendments, as support can be found, for example, in the claims of the application as originally filed.

Claim 1 has also been amended to attend to a matter of form.

II. Responses to Claim Rejections under 35 U.S.C. §112

The applicants respectfully traverse the rejection of claims 1, 3-16, and 51-56 under either 35 U.S.C. §112, second paragraph, as being indefinite. The applicants respectfully submit that the rejected claims need neither specify whether any controlling is "active (i.e., during the scan/movement," nor whether beam control involves "maintenance of the polarization," to satisfy the requirements of 35 U.S.C. §112, second paragraph. See Final Office action, page 2, paragraph 3.

Nonetheless, claims 1 and 51 have been amended in the interest of expediting the prosecution of the present application. Claim 1, as amended, now specifies that a

polarization adjusting step is performed during the directing step, and further specifies that the adjustment maintains the polarization relative to the waveguide propagation axis. Claim 51, as amended, specifies a beam control step performed during the directing step, and further specifies that the beam control maintains the polarization relative to the waveguide propagation axis.

For these reasons, the applicants respectfully request reconsideration and withdrawal of the rejections under 35 U.S.C. §112, second paragraph. The applicants also submit that the foregoing amendments should be entered, and the rejections reconsidered, at this stage, because (1) the claims are now in better form for appeal, if necessary, and (2) the applicants were first made aware of the rejections via the final Office action.

III. Responses to Claim Rejections under 35 U.S.C. §103(a)

Claims 1, 3-16, 30-42, and 51-56 stand rejected under 35 U.S.C. §103(a) as unpatentable over one or more of the following references in view of newly cited Fukuyo et al. WO 02/22301 ("Fukuyo"), for which EP 1338371 is referenced as an English-language equivalent both herein and in the Office action:

- Borelli et al. U.S. Patent Publication No. 2003/0099452 ("Borelli");
- Hirao et al., "Writing waveguides and gratings in silica and related materials by a femtosecond laser" ("Hirao"); and,
- Dugan et al. U.S. Patent No. 6,768,850 ("Dugan").

Specifically, (i) claims 1, 3-12, 15, 16, 30, 32-38, 41, 42, 51, and 53-56 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Borelli in view of Fukuyo, (ii) claims 1, 3-16, 30, 32-42, 51, and 53-56 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Borelli in view of Hirao and further in view of Fukuyo, and (iii) 1, 3-16, 30-42, and 51-56 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Dugan in view of Fukuyo.

The applicants respectfully traverse these art-based rejections of claims 1, 3-16, 30-42, and 51-56. Reconsideration and withdrawal are respectfully requested for at least the following reasons.

As set forth in MPEP §2142, three basic criteria must be met to establish a prima facie case of obviousness. First, there must be some suggestion or motivation, either in the

references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art references must teach or suggest all of the claim limitations.

A. The prior art references fail to teach or suggest all of the claim limitations

With the foregoing amendments, each of the pending claims is directed to a method of writing a waveguide in which the polarization of an ultrashort laser beam is either (i) maintained relative to a waveguide propagation axis, or (ii) in a direction parallel to a waveguide propagation axis. Specifically, each of claims 1 and 3-16 requires adjusting polarization of an ultrashort laser beam to maintain the polarization relative to a waveguide propagation axis. Each of claims 30-42 requires an ultrashort laser pulse beam having a polarization in a direction parallel to a waveguide propagation axis. Each of claims 51-56 requires controlling an ultrashort laser beam to maintain a polarization relative to a waveguide propagation axis.

The applicants respectfully submit that the cited art fails to teach or suggest an ultrashort laser beam with a polarization maintained relative to a waveguide propagation axis, much less parallel to a waveguide propagation axis.

The applicants hereby incorporate by reference the positions set forth in their previous responsive paper regarding the absence of any reference to the writing beam polarization in Borelli and Hirao, as well as the limited discussion in Dugan regarding waveguide polarization dependence. For the reasons previously stated, beam polarization relative to a waveguide propagation axis is not addressed in these references.

The applicants respectfully submit that Fukuyo fails to cure this deficiency. While Fukuyo addresses beam polarization, Fukuyo does not address polarization relative to a waveguide propagation axis. Instead, Fukuyo is directed to machining rather than waveguide writing. In short, there is no waveguide, or waveguide propagation axis, in Fukuyo.

The applicants further respectfully submit that the references in the Office action to "the direction of the cut/laser processing" and "scan/line" in Fukuyo are misplaced. Fukuyo is generally directed to cutting methods involving the creation of a modified region of

damage resulting from thermal distortion (e.g., a crack). See, e.g., col. 2, lines 50-54, in paragraph [0008]. The damaged region provides a starting point for breaking an object along the cut line (col. 2, lines 12-21, paragraph [0006]). By cut line, Fukuyo is referencing the line along which the object is to be cut, or broken. Fukuyo uses the damaged region to improve cutting efficiency and accuracy along the cut line: "If a starting point exists ...when cutting the [object], [it] will break from the starting point ... with a relatively small force" (paragraph [0122] at col. 40, lines 47-50).

But the cut line does not conform with, or correspond to, a waveguide propagation axis, or even necessarily a direction of laser processing. Indeed, the damaged region may constitute only a single spot. According to Fukuyo, cutting an object "can be achieved by a single modified region when the thickness of the object is small" (paragraph [0123], col. 41, lines 12-13). Please also see, for example, the reference to "one or a plurality of cracks" in paragraph [0124] in col. 41, line 30. In these cases, there is no laser processing line or direction, let alone a waveguide propagation axis. In other cases, a series of cracks or other damage spots are formed along the cut line. Even then, the cited art is devoid of any teaching that correlates the set of damage spots with a waveguide or a waveguide propagation axis.

Based on the foregoing, the applicants respectfully submit that the cited combinations fail to disclose or suggest polarization maintained relative to the waveguide propagation axis, as recited in claims 1 and 51, much less polarization parallel to a waveguide propagation axis, as recited in claim 30. It follows that a prima facie case of obviousness has not been established with respect to claims 1, 30 and 51, and claims 3-16, 31-42, and 52-56 by implication.

B. The requisite suggestion or motivation to modify the cited art is lacking

As described above, the cited art either fails to address beam polarization entirely, or fails to address maintaining it relative to a waveguide propagation axis. To the extent that Fukuyo addresses beam polarization, it is directed to accelerating the creation of damage, such as cracks, along the cut line. According to Fukuyo, the size of a crack spot is increased in the direction of linear polarization. Please see, e.g., paragraph [0215] at col. 64, lines 10-15. The cracks and other damage are the desired results in Fukuyo, and linear polarization helps meet that goal more efficiently.

The applicants respectfully submit that the increased creation and acceleration of damage would not suggest or motivate one skilled in the art to modify the waveguide writing techniques discussed in the other references. Cracks and other damage would only impair the propagation of light. The skilled artisan would therefore not consider it desirable to modify Borelli, Dugan or Hirao with the teachings of Fukuyo. If anything, the focus on the creation of damage in Fukuyo teaches away from the use of beam polarization in waveguide writing.

More generally, the cited art fails to address aspects of waveguide writing related to the waveguide propagation axis, let alone any relationship between beam polarization and the waveguide propagation axis. It follows that the cited art fails to suggest the desirability of beam polarization maintenance relative to the waveguide propagation axis, much less the desirability of beam polarization parallel to the waveguide propagation axis.

For these reasons, the applicants respectfully submit that the requisite motivation or suggestion to modify the cited art to involve the requisite beam polarization maintenance (or parallel beam polarization) is lacking. The applicants accordingly submit that a prima facie case of obviousness has not been established for claims 1, 30, and 51. It follows that claims 1, 3-16, 30-42, and 51-56 recite patentable subject matter over the cited art.

C. A reasonable expectation of success is also lacking

The applicants respectfully traverse the assertion in the Office action that there would be "a reasonable expectation of decreasing artifacts/defects," if the waveguide writing techniques of the cited art utilized beam polarizations as taught by Fukuyo (Office action, page 3, third paragraph). Fukuyo, in fact, advocates an exact opposite result -- creating damage along the cut line. As described above, aligning the beam polarization with the cut line only increases and accelerates the damage along the cut line.

That Fukuyo is also concerned with fractures that deviate from the cut line does not change the fact that, to Fukuyo, damage is desirable. A skilled artisan would still consider Fukuyo to teach that, if anything, one should expect increased damage along the cut line with an aligned beam polarization. As a side note, the applicants submit that fractures may run perpendicular to the beam polarization -- a finding that may reveal differences in the laser regimes utilized (e.g., ultrashort vs. non-ultrashort). But even if taken at face value, Fukuyo's

cracking results would be considered highly undesirable in connection with waveguide formation, leading to little to no expectation of success.

D. The Benefits of Beam Polarization Maintenance

The applicants respectfully traverse the assertion in the Office action that Fukuyo teaches the benefits of maintaining or controlling beam polarization, as described in the present application. Specifically, the Office action asserts that the benefits ascribed to the beam polarization are taught by Fukuyo, referencing two portions of the present application. Please see the first paragraph on page 4 of the Office action. While the two portions of the present application generally recognize the undesirable nature of cracks, a more complete picture of the benefits ascribed to the claimed techniques by the applicants is set forth elsewhere in the application. These benefits are not taught by Fukuyo, as explained below.

First and foremost, the present application describes how cracks running along the waveguide propagation axis can “drastically reduce the waveguide light throughput” (page 17, lines 31-32). The applicants respectfully submit that avoiding cracks along a waveguide propagation axis is not a benefit taught by Fukuyo, for the reasons stated above. In short, Fukuyo advocates the formation of cracks, especially along the cut line.

The present application also describes a number of benefits – also missing from Fukuyo – in connection with beam polarization in a direction parallel to the waveguide propagation axis, as recited in claim 30. The application states at page 18, lines 6-10, with emphasis added:

[W]hen the laser polarization is parallel to the waveguide propagation axis, the cracks are much less frequent and, when they do appear, they run perpendicular to the waveguide axis terminating at the edge of the waveguide. This naturally makes the cracks short, and they do not affect the waveguide transmission as severely as in the former case.

Fukuyo would lead one skilled in the art to expect the exact opposite, namely that beam polarization would (1) make cracks more rather than less frequent, (2) align the cracks with the beam polarization rather than in a perpendicular direction, and (3) thus lead to decreased waveguide transmission.

IV. Conclusion

For the foregoing reasons, it is submitted that all pending claims 1, 3-16, 30-42, and 51-56 are in condition for allowance, and an indication to that effect is solicited.

Should the examiner wish to discuss the foregoing or any matter of form in an effort to advance this application toward allowance, the examiner is urged to telephone the undersigned at the indicated number.

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Respectfully submitted,

By 

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